

LB/ DON /68/04 No 15

USE OF GRADE 25 CONCRETE IN DESIGN OF WATER RETAINING STRUCTURES BASED ON BS 8007 RECOMMENDATIONS

By

W.W Liyanage



University of Moratuwa, Sri Lanka
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

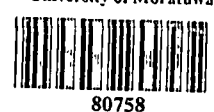
THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE DEGREE OF MASTER OF ENGINEERING IN STRUCTURAL ENGINEERING DESIGN

Supervised By
Dr. S.M.A. Nanayakkara



621.953:691.3

University of Moratuwa



80758

UM Thesis coll.

80758

Department of Civil Engineering
University of Moratuwa
Sri Lanka
January 2004
80758

This thesis has not been previously presented in whole or part to any university or institute for higher degree.



University of Moratuwa, Sri Lanka
Electronic Theses & Dissertations
www.lib.mrt.ac.lk



.....

(W.W.Liyanage)

January 2004

ACKNOWLEDGEMENT

I take this opportunity express my gratitude and indebtedness to my supervisor Dr.S.M.A.Manayakkara, Senior Lecture in Structural Engineering at the University of Moratuwa, for his scholarly guidance and advice at every stage of the research study, to complete it successfully.

I am grateful to the National Water Supply & Drainage Board and University of Moratuwa for the assistance extended to me.

Also, I am extending my gratitude to Librarian and her staff of the National Water Supply & Drainage Board and Sri Lanka Standard Institution for providing very valuable documents, reports and photographs to me.



Finally, I offer my appreciation to the National Water Supply & Drainage Board officers those who are attached to the Planning & Design Section, Construction Section, Regional Support Center (Central), Greater Galle Water Supply Scheme, Anuradhapura Group Town Water Supply Scheme and Mr. Rojes Perera of State Development & Construction Corporation (SD&CC) for providing various test reports, photographs and other required information. Also offer my appreciation to Miss Vajira Malkanthi and Miss Iresha Rukshani for giving valuable assistance to me in preparing of this report.

W.W.Liyanage.

ABSTRACT

The grade of concrete is very important for strength and durability of reinforced concrete structures. Although strength and durability of concrete are inter-related, it is not always true that high strength concrete has high durability. This is because, the durability depends on the porosity of concrete rather than strength. As far as the reinforced concrete water retaining structures are concerned, the durability requirements are more demanding because concrete is subjected to more severe environmental conditions in those structures. Because of this reason, higher grade of concrete is normally specified for reinforced concrete water retaining structures.

In the recent past, Grade 25 concrete was used for water retaining structures based on BS 5337 recommendation. Even before BS 5337 came into practice, the nominal mixes such as 1:1½:3 (equivalent to grade 25) were used for water retaining structures. At present, recommendations given in BS 8007 are used for design and construction of water retaining structures in Sri Lanka in which minimum recommended grade of concrete is grade 35. Furthermore, the maximum cement content is limited to 400 kg/m³ in the present code. Because of these recommendations, there is difficulty in adopting BS 8007 due to inability to produce grade 35 concrete in Sri Lanka, especially in volume batched concrete. In this context, this study was carried out to explore the possibility of using Grade 25 concrete with the design recommendations given in BS 8007.

A literature survey was carried out to find out the design practices in other countries such as India, U.S.A., and Australia. A field survey was carried out


to collect information on durability and the performance of the water retaining structure built using Grade 25. In addition, information was collected on production of Grade 25 and 35 concrete for construction of water retaining structures in Sri Lanka.

It was found that the Indian standard recommends grade 25 concrete for water retaining structures and all other codes recommend higher grades of concrete for water retaining structures. Furthermore, it was observed that concrete in almost all the structures, which were design and built based on BS 5337 and CP 2007 are in good conditions. The collected concrete strength data shows that the production of Grade 35A concrete by volume batching was not that successful. But it is possible to obtain Grade 25 concrete without any difficulty even with volume batching. Furthermore, design calculations showed that the reinforcement requirement to control thermal and shrinkage cracks could be reduced with the use of lower grade of concrete such as Grade 25 concrete. Finally, amendments are proposed to design recommendation given in BS 8007 to accommodate Grade 25 concrete.

Based on this study it can be concluded that Grade 25 concrete can be used with design recommendation given in BS 8007 to design water retaining structures more economically.

C O N T E N T

	Page No.
<i>Acknowledgement</i>	ii
<i>Abstract</i>	iii
<i>Content</i>	v
1. Introduction	
1.1 General	01
1.2 Objective of Study	04
1.3 Methodology	04
2. Historical background	
2.1 General	05
2.2 Performance of the existing water retaining Structures in Sri Lanka	06
3. Grade of concrete	
3.1 General	26
3.2 Quality of cement	26
3.3 Mix design	28
3.4 Mix design information and test cube results of already completed project	30
4. Comparison of BS 5337 and BS 8007	
4.1 General	34
4.2 Design objective and general recommendation	34

4.3	Design and detailing of reinforced concrete	42
4.4	Design and detailing of pre-stressed concrete	42
4.5	Design detailing and workmanship of joints	43
4.6	Specification and materials for concrete	44
4.7	Specification and workmanship of reinforcement	45
4.8	Specification and workmanship for pre-stressing tendon	46
4.9	Inspection and testing of the structure	46
4.10	Calculation of minimum reinforcement, crack spacing and crack width in relation to temperature and moisture effect	46
4.11	Calculation of crack spacing and crack width in mature concrete	47
 University of Moratuwa, Sri Lanka Electronic Theses & Dissertations www.lib.mrt.ac.lk		
5	Review of various codes of practice for the design of liquid retaining structures	
5.1	General	53
5.2	Australian Standard	53
5.3	Indian Standard	57
5.4	American Standard	59
6	Recommendation on use of grade 25 concrete for water retaining structures	
6.1	General	63
6.2	Recommendation of BS 8007 relating to grade of concrete	63
6.3	Control of cracking due to thermal and moisture movement	66



6.4	Proposed amendments	70
7	Conclusions	73
	Appendix A	
A.1	Design tables	75
Table A1.	Grade 25 concrete 0.1 mm crack width	87
Table A2.	Grade 25 concrete 0.2 mm crack width	99
Table A3.	Grade 35A concrete 0.1 mm crack width	111
Table A4.	Grade 35A concrete 0.2 mm crack width	123
	Appendix B	
B- 1	Mix design reports and cube test reports for grade 35A concrete	135
B - 2	Mix design reports and cube test reports for grade 25 concrete	142
B – 3	Analysis of tank wall	146
	Design calculations according to BS 5337	150
	Design calculation according to BS 8007	159